

D.P.U. 92-274

Petition of Massachusetts Municipal Wholesale Electric Company for approval of its 1991 Long-range requirements and resources from 1991 through 2001.

APPEARANCES: Robert M. Granger, Esq.
Nicholas J. Scobbo, Esq.
Fertter, Scobbo, Sikora, Singsal, Caruso & Rodophel
One Beacon Street
Boston, Massachusetts 02108
FOR: MASSACHUSETTS MUNICIPAL
WHOLESALE ELECTRIC COMPANY
Applicant

I.	<u>I NTRODUCTI ON</u>	1
II.	<u>STANDARD OF REVI EW</u>	2
A.	<u>Company's Posi ti on</u>	2
B.	<u>Analysi s and Fi ndi ngs</u>	5
1.	<u>Demand Forecast</u>	5
2.	<u>Supply Pl an</u>	6
C.	<u>Standard of Revi ew for MMWEC's Supply Pl an</u>	8
III.	<u>ANALYSIS OF THE DEMAND FORECAST</u>	9
A.	<u>Standard of Revi ew</u>	9
B.	<u>Previ ous Demand Forecast Revi ew</u>	9
C.	<u>Energy Forecast</u>	11
1.	<u>Economi c and Demographi c Forecast</u>	12
2.	<u>Electri ci ty Pri ce Forecast</u>	13
a.	<u>Descri pti on</u>	13
b.	<u>Analysi s and Fi ndi ngs</u>	14
3.	<u>Resi denti al Energy Forecast</u>	14
a.	<u>Number of Customers</u>	15
b.	<u>Number of Appl i ances per Customer</u>	16
(1)	<u>Descri pti on</u>	16
(2)	<u>Analysi s and Fi ndi ngs</u>	17
c.	<u>Average Use per Appl i ance</u>	18
(1)	<u>Descri pti on</u>	18
(2)	<u>Analysi s and Fi ndi ngs</u>	19
d.	<u>Conclusi ons on the Resi denti al Sector Forecast</u>	19
4.	<u>Commerci al Energy Forecast</u>	20
a.	<u>End Uses Modell i ng Methodology</u>	21
(1)	<u>Descri pti on</u>	21
(2)	<u>Analysi s and Fi ndi ngs</u>	22
b.	<u>Floor Space</u>	23
c.	<u>End-Use Saturati on and Market Share for Electri ci ty</u>	24
d.	<u>End Use Intensi ti es</u>	24
(1)	<u>Descri pti on</u>	25
(2)	<u>Analysi s and Fi ndi ngs</u>	26
e.	<u>Conclusi ons on the Commerci al Sector Forecast</u>	26
5.	<u>Industri al Energy Forecast</u>	26
a.	<u>Base Year Electri c Use per Employee</u>	27
b.	<u>Changes i n Electri c Use per Employee</u>	28
(1)	<u>Descri pti on</u>	28
(2)	<u>Analysi s and Fi ndi ngs</u>	31
c.	<u>Conclusi ons on the Industri al Sector Forecast</u>	32
6.	<u>Forecast for Muni ci pal , Street Li ghti ng, and Other Energy</u>	32

D.	<u>Conclusions on the Energy Forecast</u>	33
E.	<u>Peak-Load Forecast</u>	34
1.	<u>Description</u>	34
2.	<u>Analysis and Findings</u>	37
3.	<u>Compliance with Directive Twelve Regarding MMWEC's Peak Load Forecast</u>	38
F.	<u>Conclusions on the Demand Forecast</u>	39
IV.	<u>ANALYSIS OF THE SUPPLY PLAN</u>	39
A.	<u>Standard of Review</u>	39
B.	<u>Previous Supply Plan Review</u>	41
C.	<u>Supply Planning Process</u>	41
D.	<u>Adequacy of the Supply Plan</u>	43
1.	<u>Base Case Supply Plan</u>	43
2.	<u>Adequacy Analysis</u>	43
a.	<u>Assessment of Supply-Demand Balance</u>	43
b.	<u>MMWEC's Position in the Power Market</u>	44
c.	<u>Conclusions on Adequacy</u>	45
E.	<u>Cost Analysis</u>	46
1.	<u>Identification of Resource Options</u>	46
a.	<u>Available Resource Options</u>	46
(1)	<u>Types of Resource Sets</u>	47
(2)	<u>Compilation of Resource Sets</u>	47
(a)	<u>Other Utilities</u>	47
(b)	<u>NUGs</u>	48
(c)	<u>New MMWEC Generation</u>	48
(d)	<u>Emerging Technologies</u>	49
(e)	<u>DSM Options</u>	50
(3)	<u>Conclusions on Available Resource Options</u>	50
b.	<u>Development and Application of Screening Criteria</u>	51
(1)	<u>Supply-Side Resources</u>	52
(2)	<u>Demand-Side Management Resources</u>	55
(3)	<u>Conclusions on Development and Application of Screening Criteria</u>	58
c.	<u>Conclusion on Identification of Resource Options</u>	59
2.	<u>Cost Effectiveness</u>	59
a.	<u>Cost Effectiveness Methodology</u>	59
b.	<u>Public Interest</u>	63
c.	<u>Conclusions on Cost Effectiveness</u>	63
F.	<u>Conclusions on the Supply Plan</u>	63
V.	<u>DECISION</u>	64
	<u>TABLES</u>	65

I. INTRODUCTION

On January 10, 1992, pursuant to G.L. c. 164, § 69I, Massachusetts Municipal Wholesale Electric Company ("MMWEC" or "Company") filed with the Department of Public Utilities ("Department") a petition for approval of its joint long-range forecast of electric power needs and requirements. On September 1, 1992, the functions of the Siting Council were merged into the Department of Public Utilities under a reorganization plan filed by the Governor, allowed by the General Court, and enacted as Chapter 141 of the Acts of 1992. Pursuant to Chapter 141, MMWEC's petition became subject to the jurisdiction of the Department, and was docketed as D.P.U. 92-274.

MMWEC is a public corporation of the Commonwealth, created under Chapter 775 of the Acts of 1975. MMWEC provides a variety of services, including forecasting and supply planning services to 29¹ municipally owned electric systems ("members" or "member systems") in Massachusetts. MMWEC's joint planning activities for member systems include: preparing demand forecasts; financing, owning, and operating generating resources; analyzing and assisting in the implementation of conservation and load management ("C&LM") programs; contracting for the sale and interchange of electric power among members and with other utilities; and providing coordination with the New England Power Pool ("NEPOOL").

At the time of the filing of the instant petition, MMWEC provided services to the following member systems: Ashburnham, Belmont, Boylston, Concord, Danvers,

¹ The number of members may change from time to time.

Georgetown, Groton, Hingham, Holden, Holyoke, Hull, Ipswich, Littleton, Mansfield, Marblehead, Merriam, Middleton, North Attleboro, Paxton, Princeton, Reading, Rowley, Shrewsbury, South Hadley, Sterling, Templeton, Wakefield, West Boylston, and Westfield (Exh. MM-1, at 1-1). During the course of this proceeding one member system, the Reading Municipal Light Department, terminated its membership in MMWEC (Tr. 1, at 20).

In 1990, the member systems experienced a non-coincident summer peak demand of 689 megawatts ("MW") and a non-coincident winter peak demand of 656 MW (Exh. M-1, at 11.A.). MMWEC sells approximately 3,800,000 megawatt hours ("MWH") per annum of electricity to about 183,140 customers in a non-continuous service area (Exh. M-3, at 1).

Pursuant to notice duly issued, four days of evidentiary hearings were held at the offices of the Department on July 28 and 29 and September 14 and 15, 1993. There were no petitions for leave to intervene. In support of its petition, the Company sponsored the testimony of two witnesses: Robert L. Stinson, forecasting manager for MMWEC, who testified with respect to the Company's demand forecast; and John J. Boudreau, strategic resource planning manager for MMWEC, who testified with respect to the Company's supply plan.

The evidentiary record includes 149 exhibits submitted by the Department, five exhibits submitted by MMWEC and 33 responses to record requests issued by the Department. The Company filed a brief in support of its petition.

II. STANDARD OF REVIEW

A. Company's Position

MMWEC argues that the standards of review developed by the Siting Council for both

the demand forecast and supply plan portions of a company's long-range forecast are inconsistent with G.L. c. 164, § 69I and, therefore, invalid (Company Brief at 14-15). MMMEC maintains that the Department must adhere strictly to the requirements set forth in § 69I (i.d. at 10). Section 69I provides that long-range forecasts contain the following:

all information relating to the current activities, environmental impacts, facilities agreements and energy policies as adopted by the commonwealth is substantially complete; projections of the demand for electric power... and the of capacities for existing and proposed facilities are based on substantially accurate historical information and reasonable statistical projection methods and include an adequate consideration of conservation and load management; ...projections relating to service area, facility use and pooling or sharing arrangements are consistent with such forecasts of other companies subject to this chapter as may have already been approved and reasonable projections of activities of other companies in the area; plans for expansion and construction of the applicant's new facilities are consistent with current health, environmental protection, and resource use and development policies as adopted by the commonwealth; and are consistent with the policies state in section sixty-nine H to provide a necessary energy supply to the commonwealth with a minimum impact on the environment at the lowest possible cost.

According to the Company, the first three requirements of § 69I relate to the quality of the information filed and require that: (1) such be accurate and complete; (2) projections be based on accurate historical data and reasonable statistical projection methods, including C&LM; and (3) "projected supply arrangements must be consistent with the approved forecasts and projected activities of other utilities" (i.d. at 11). In addition, MMMEC argues that the remaining requirements of § 69I are applicable only for proposed new facilities (i.d.). The Company asserts that forecasts that do not contain proposals for new facility construction are "only informational" (i.d. at 13).

With respect to the Department's review of a company's demand forecast, MMMEC

argues that the existing three-prong test, "reasonable, appropriate, and reliable", is inconsistent with §69I's mandate that a demand forecast be based on a "reasonable statistical method" (i.d. at 15). MMWEC asserts that the statute requires that the Department determine whether a company "has used numerical data in a rational way in predicting future demand" (i.d. at 15-16). MMWEC maintains that the existing standard supplants the expert judgment of a company with respect to statistical methodologies with the subjective perspective of the Department on said approaches (i.d. at 16).

Regarding the Department's review of a utility's supply plan, the Company argues that §69I does not require nor does it permit the Department to review an electric company's supply plan, except in the instance of a proposed new facility (i.d. at 18, 20). Moreover, MMWEC asserts that the standards of adequacy and cost developed by the Siting Council for review of a company's supply plan are inconsistent with §69I (i.d. at 18).

With respect to the adequacy component in the Department's standard of review, MMWEC argues that the focus of §69I lies with the need for, and the environmental impact of any new facility proposed by a company, and that the review of the adequacy of a company's supply plan is not within the scope of the statute (i.d.). As to the aspect of cost in the Department's standard of review of supply, MMWEC contends that rules of statutory construction dictate that "lowest possible cost" as stated in §69I relates only to the words "minimum impact on the environment" found in that section and not to a supply plan generally (i.d. quoting Moulton v. Brookline Rent Control Board, 385 Mass. 228, 230-231 (1982)).

Alternatively, MMWEC argues that even if the Department rejects the Company's

arguments and continues to apply the standards developed by the Siting Council, the Department should approve MMWEC's filing (id. at 29).

B. Analysis and Findings

1. Demand Forecast

As noted, MMWEC argues that the three-prong test of "reasonable, appropriate, and reliable" developed by the Siting Council for review of a company's demand forecast is inconsistent with §69I. This test provides a logical framework for the Department to review a company's demand forecast, in light of the required components of a demand forecast as set forth in §69I. Therefore, it is not inconsistent but is rather a mechanism to assure that the statutory mandate has been fulfilled. Thus, we find that MMWEC's assertion is without merit.

Moreover, in seeking to assure that companies subject to §§ 69I -J meet the requirements set forth therein, the Department may interpret the statute and weight should be given "to any reasonable construction of a regulatory statute adopted by the agency charged with...[its] enforcement." Investment Co. Inst. v. Camp, 401 U.S. 617, 626-7 (1970).

Furthermore, so long as the agency's interpretation of its statutory mandate is rational and adhered to consistently, it should be respected. Northbridge v. Natick, 394 Mass. 644, 650 (1983). An examination of the pertinent cases decided by the Siting Council demonstrates that this agency, formerly charged with enforcing §69I -J, consistently had applied the three-prong test of reasonableness, appropriateness and reliability in reviewing companies' demand forecasts. Commonwealth Electric Company and Cambridge Electric Light Company, 220 DOMSC 116 (1991); Nantucket Electric Company, 21 DOMCS 208 (1991); Massachusetts

Electric Company/ New England Power Company, 18 DOMSC 295 (1989). Accordingly, the Department will continue to apply the standard of review which has been applied to the demand forecast portion of companies' long-range forecast filings.

2. Supply Plan

As indicated, MMWEC has argued that, where a company's forecast filing does not incorporate proposed new facilities, a company's supply plan filing merely is informational in nature. MMWEC's interpretation contravenes the explicit mandate contained in § 69I to review every long range forecast filing by way of an adjudicatory proceeding under the provision of G.L. c. 30A. Moreover, we do not discern any context in the language of the statute to support the assertion made by the Company.

The Siting Council, adhering to the statutory mandate of § 69I, consistently had reviewed forecast filings regardless of whether a company proposes new facilities. See, e.g., Braintree Electric Light Department, 24 DOMSC 1,5 (1992); Nantucket Electric Company, 21 DOMSC 208, 214 (1991); Commonwealth Electric Company and Cambridge Electric Light Company, 22 DOMSC 116,126 (1991). Accordingly, the Department rejects MMWEC's contention that, absent a proposal for new facilities, a filing is merely informational.

Regarding MMWEC's contention that a review of the adequacy of a company's supply plan is inconsistent with § 69I, MMWEC's argument overlooks the broad statutory mandate in § 69I which requires the Department to review a company's forecast filing to ensure that it provides a necessary energy supply. The review of the adequacy of a plan is one method employed by the Department to ensure that the statute's intent with regard to

ensuring a necessary energy supply has been fulfilled.

With regard to the issue of cost, as noted, MMWEC asserts that the Department's consideration of cost in reviewing a supply plan is inconsistent with §69I. MMWEC's interpretation that "lowest possible cost" relates only to environmental impacts is incorrect and inconsistent with long-standing Department precedent. Accordingly, the Department will continue to review the cost of MMWEC's supply plan.

Notwithstanding our determination above, we note that, unlike other electric utilities in the Commonwealth, MMWEC's role with respect to member utilities is advisory in nature, and as a result, the potential exists for discordance between the supply planning process employed by MMWEC and the subsequent implementation by member systems of a supply plan recommended by MMWEC. Moreover, the Supreme Judicial Court of the Commonwealth has held that the Company cannot be ordered to submit individual member forecasts as part of its long-range forecast filing. Massachusetts Municipal Wholesale Electric Company v. Energy Facilities Siting Council, 411 Mass. 183, 184 (1991). As the Court stated, MMWEC had fulfilled its statutory obligation by filing a joint long-range forecast, and that MMWEC's members also fulfilled their statutory obligation by participating in said joint filing. Id. at 190. In light of these considerations, the Department's review of MMWEC's supply plan filing under the existing framework for review, is not appropriate.

Accordingly, the Department finds that the degree of scrutiny which heretofore has been applied to the review of adequacy and cost of MMWEC's supply plan filing must be modified in order to establish a framework which is consistent with MMWEC's nature as an

advisory body to its constituent members, and consistent with the particular statutes governing the responsibilities of MMWEC. This modified standard of review applies only to the Department's review of MMWEC's supply plan.

C. Standard of Review for MMWEC's Supply Plan

In keeping with its mandate in G.L. c. 164, § 69H, to "provide a necessary energy supply for the commonwealth with a minimum impact on the environment at the lowest possible cost," the Department reviews two dimensions of MMWEC's supply plan: adequacy and cost.

The adequacy of supply is a utility's ability to provide sufficient capacity to meet its peak loads and reserve requirements through the forecast period. Cambri dge Electric Light Company, 12 DOMSC 39, 72 (1985); Boston Edison Company, 10 DOMSC 203, 245 (1984). With respect to the adequacy of MMWEC's supply plan, MMWEC must demonstrate that the Company and its members in aggregate own or have under contract sufficient resources to meet projected, aggregate capability responsibility throughout the forecast period, or that MMWEC operates according to a specific action plan to meet this responsibility.

Regarding cost, MMWEC must demonstrate that it has identified and demonstrated the cost-effectiveness of a variety of supply options. In order to demonstrate such, MMWEC must show that it has examined a reasonable range of resources to meet its projected aggregate capability responsibility by (1) compiling a reasonable array of available resource options, and (2) developing and applying appropriate criteria for screening its array of available resource options.

Finally, as part of its supply plan process, MMWEC also must demonstrate that recommended resource options are (1) cost-effective compared to available alternatives, using methods such as competitive solicitations open to all bidders, and (2) not otherwise contrary to the public interest.

III. ANALYSIS OF THE DEMAND FORECAST

A. Standard of Review

Pursuant to its statutory mandate "to provide a necessary energy supply for the commonwealth with a minimum impact on the environment at the lowest possible cost", incorporated in G.L. c. 164, § 69H, the Department determines whether "projections of the demand for electric power ... are based on substantially accurate historical information and reasonable statistical projection methods." G.L. c. 164, § 69J. To ensure that the foregoing standard is met, the Department applies three criteria to demand forecasts: reviewability, appropriateness, and reliability.

A demand forecast is reviewable if it contains enough information to allow full understanding of the forecast methodology. A forecast is appropriate if the methodology used to produce that forecast is technically suitable to the size and nature of the utility that produced it. A forecast is reliable if the methodology provides a measure of confidence that its data, assumptions, and judgments produce a forecast of what is most likely to occur. Boston Edison Company, 15 DOMSC at 287, 294 (1987) ("1987 BECo Decision").

III. Previous Demand Forecast Review

In Massachusetts Municipal Wholesale Electric Company, 20 DOMSC 1 (1990), aff'd in part, rev'd in part, 411 Mass. 183 (1991) ("1990 MMWEC Decision"), the Siting Council

approved MMWEC's demand forecast, subject to twelve orders² applicable to the instant forecast filing, finding that MMWEC should:

1. Examine its residential customer survey methodology to determine methods of increasing response rates in certain systems;
2. Demonstrate that appliance type saturation data used for all systems are representative of appliance ownership decisions of residential customers in those systems;
3. Fully explain and justify its assumption that miscellaneous appliance type average use consists of six percent of MMWEC's weather-insensitive load;
4. Fully identify the virtues of New England Power Pool ("NEPOOL") data used to establish MMWEC base year average residential use estimates;
5. Fully explain and justify (1) MMWEC's procedure for determining which member systems are subject to significant level of seasonal customer consumption effects, (2) the ability of MMWEC's calibration process to reflect the effects of seasonal customer consumption on appliance average use estimates, and (3) any adjustments to average appliance use designed to reflect the effects of seasonal customer consumption and which take place following calibration;
6. Present its analysis regarding the validity of the rebound effect, based on major studies and research projects which have addressed the rebound effect and drawn conclusions regarding its validity;
7. Fully reevaluate its use of constant floor space per employee ratios, including justification of the use of these ratios with respect to other reasonable methods of commercial floor space growth estimates;
8. Identify additional commercial end uses to be disaggregated, or fully justify the present level of commercial end-use disaggregation, and fully explain all methodologies used to determine commercial end-use saturations, including space cooling saturations;

² The numbers preceding each order correspond to their order of presentation in the 1990 MMWEC decision.

9. Establish service territory-specific miscellaneous energy use intensity ("EUI") growth rates or fully justify use of non-service territory-specific data;
10. Justify any further use of NEPOOL industrial energy intensity trend factors, and demonstrate that NEPOOL intensity trend factors are reasonable predictors of MMWEC's industrial sector consumption characteristics;
11. Describe fully and justify its methodology for forecasting municipal, street lighting, and "other uses" energy requirements; and
12. Develop and present an analysis of alternative peak load forecasting methodologies, including (1) the ability of alternative methodologies to reflect the major underlying factors of peak load such as weather effects and varying consumption patterns over different months, days, and hours, (2) the level of disaggregation achieved by each alternative methodology, and (3) a time schedule for implementing improvements to MMWEC's peak load forecasting methodology.

1990 MMWEC Decision at 17-35.

MMWEC's response to these orders is discussed in Sections III.C. and III.D below. MMWEC fully complied with directives 1-2, 4-7, and 9-12. MMWEC responded to directive 3 by discounting its assumption. However, regarding directive 8, the Department needs further information from MMWEC in its next filing.

B. Energy Forecast

MMWEC forecasted annual energy requirements by first preparing electricity type, demographic and employment forecasts, then applying those forecasts in detailed end-use and econometric models (Exh. M-1, at 11-1 through 11-6). MMWEC forecasted the energy requirements for the residential, commercial and industrial sectors, as well as for street

lighting, municipal use, "other use," and losses (i.d.).³

MMWEC forecasted its system-wide energy requirements to increase at a compound annual growth rate of 1.9 percent over the forecast period (Exh. M-3, at 1). In addition, MMWEC forecasted its non-coincident peak loads to increase at compound annual growth rates of 2.0 percent in winter and 1.8 percent in summer (i.d.).

1. Economic and Demographic Forecast

MMWEC used fall 1991 and fall 1992 Data Resources, Inc. ("DRI") data for fuel price data and national macroeconomic data⁴ (Exhs. M-1 at 11-16; DPU-2; DPU-3). MMWEC used its own mail surveys to determine base year household income and base year commercial floorspace (Exhs. DPU-4; M-1, at 11-36). MMWEC obtained employment data from two-digit Standard Industrial Code ("SIC") for non-industrial SICs and some industrial SICs from the Massachusetts Department of Employment and Training ("MDET"), with the balance of industrial employment data from secondary sources and MMWEC member staffs (Exh. M-1, at 11-36 and 11-50). To forecast changes in key economic factors, including statewide employment by business type⁵ and household income, MMWEC incorporated New England Power Planning ("NEPLAN") forecast outputs into the Regional Economic

³ MMWEC stated that in 1991 its total energy use was 3,727,180 megawatt-hours (MWH) (Exh. M-3, at 1). This represents almost nine percent of all retail electricity sales in Massachusetts for that year.

⁴ MMWEC used the more recent DRI data for its February 1993 forecast update (Exhs. M-3; DPU-3).

⁵ This in turn was used to forecast changes in commercial floorspace (Exh. M-1, at 11-36 through 11-39; DPU-41).

Modeling system ("REMI") (Exhs. M-1, at 11-35; DPU-2; DPU-3). MMWEC has retained some of these organizations in the past for these services.⁶ See 1990 MMWEC Decision at 15.

MMWEC stated that it obtained population forecasts for member systems from the Massachusetts Institute for Social and Economic Research ("MISER"), a change from the regional planning commission data previously used (Exh. M-1, at 11-5; See 1990 MMWEC Decision at 15). MMWEC added that it again obtained household size projections from the U.S. Census Bureau ("Census") (Exh. M-1, at 11-5).

For purposes of this review, the Department accepts MMWEC's methodologies for forecasting economic and demographic factors.

2. Electricity Price Forecast

a. Description

MMWEC forecasted electricity prices based on revenue requirements projected using the PROSCREEN long-term generation planning model (Exh. M-1, at 11-16). MMWEC used the following types of inputs in the PROSCREEN model: (1) MMWEC system load data; (2) generator data for NEPOOL units, including MMWEC units; (3) other MMWEC system data and escalation rates; (4) DRI's Fall 1991 fuel price forecast; and (5) several types of data for member utilities⁷ (i.d.; Exh. DPU-15). MMWEC forecasted separate real

⁶ MMWEC stated that several Massachusetts electric utility forecasts use MI data, that various state agencies use the REMI model (Tr. 1, at 19-22). MMWEC also stated that the NEPLAN results are available to all NEPOOL members (i.d.).

⁷ These data include benchmark 1990 retail rates, operation and maintenance ("O&M")
(continued...)

(adjusted for inflation) prices for the residential, commercial, and industrial classes (Exh. M-1, at 11-18). Some real prices rise early in the forecast period, and again at the end, but real prices fall in most years, so that, by the end of the forecast period, real prices in all three classes ultimately decline (*i.d.*). MMWEC's electricity price forecast methodology represents a significant change from MMWEC's previous trend factor methodology. See 1990 MMWEC Decision at 12.

b. Analysis and Findings

The Department finds that MMWEC's current methodology represents a significant improvement over the previous trend factor methodology. In particular, it projects prices to increase in some years and to decrease in others, as is actually observed when additional resources are added or are not added in particular years. This effectively addresses the Sitting Council's primary concern with the methodology used in the previous MMWEC order. See 1990 MMWEC Decision at 12-14. The Department notes that MMWEC has used appropriate inputs to forecast the actual operation of its system. Accordingly, the Department finds that MMWEC has established that its electricity price forecasting methodology is acceptable.

3. Residential Energy Forecast

MMWEC stated that its 1991 residential electricity use was 1,307,652 MWh, or 35 percent of total use (Exh. M-3, at 1). MMWEC forecasted a 1.0 percent annual compound residential growth rate over the forecast period (*i.d.*).

⁷(...continued)

costs, debt service, inflation-of-tax payments, and equipment depreciation (Exh. DP-16).

MMWEC based its residential energy forecast on the assumption that total consumption is the sum of consumption of 21 residential appliance types (Exh. M-1, at 11-3 and 11-3).⁸ The basic premise underlying this forecast is that annual energy consumption of an appliance type is the product of the number of customers, the number of appliances per customer, and the average use per appliance (*i.d.* at 11-3). MMWEC has enhanced a few methodological aspects of its residential energy forecast, but the basic residential forecast structure remains largely the same as the one previously approved by the Siting Council. 1990 MMWEC Decision at 10-19.

a. Number of Customers

MMWEC stated that it represented the number of customers by the number of households (Exh. M-1, at 11-5 through 11-8). MMWEC stated it determined the projected number of households by dividing the forecasted population in member service territories by forecasted U.S. average household size, using MISO data and Census data, respectively (*i.d.* at 11-5). MMWEC assumed that average household size among its members would change at the same annual rate as the U.S. average (*i.d.*).

For purposes of this review, the Department finds that MMWEC's methodology for forecasting the number of residential customers is acceptable.

⁸ The 21 appliances types, in order by 1991 energy sales, include: refrigerator, clothes dryer, electric water heater, electric space heating, lighting, television, electric range, freezer, room air conditioner, fan, dishwasher, fossil heating (gritters, fans, pumps), microwave oven, dehumidifier, water bed, water (well) pump, clothes washer, central air conditioning, humidifier, and supplemental electric space heat (Exh. M3, at 3). The first seven appliance types, plus miscellaneous use (6 percent), account for 79 percent of MMWEC residential sales (*i.d.*).

b. Number of Appliances per Customer

(1) Description

MMWEC established base year number of appliances per customer ("saturations"), using its 1990 Consumer Energy Survey of 4,600 households and 1990 reports submitted to the Department (Exh. M-1, at 11-3 and 11-7). MMWEC's reported 26.4 percent response rate for its 1990 survey was lower than the response rate for any of its member systems in the previous survey (Exh. DPU-6; See 1990 MMWEC Decision at 17). MMWEC claims that the response rate to the 1990 Survey allows 99 percent confidence that saturation estimates are accurate within 1.9 percent (Exh. M-1, at 11-7; Tr. 1, at 29). MMWEC states that it compares its survey results with those of other Massachusetts utilities (Tr. 1, at 30). MMWEC discussed several reasons for non-responses, concluded that only one of them would bias the results, and stated that it did not consider non-response bias in the residential survey among its greater concerns in forecasting (i.d. at 32-34).

MMWEC projected saturations by applying growth rates to the base year estimates, using four methods: (1) saturation-income regression analysis; (2) assumed constant saturations; (3) ceiling saturation values; and (4) a space heating fuel choice model (Exh. M-1, at 11-7). MMWEC used the first method for 15 appliances, the second method for five appliances,⁹ the third method for room air conditioning,¹⁰ and the fourth method

⁹ These five appliances are lighting, solar water heating, black and white televisions, standard freezers and miscellaneous (Exh. M-1, at 11-13). MMWEC states that lighting and miscellaneous are universal in nature (i.e., the saturations are always 10) and that MMWEC deemed it appropriate to use constant saturations for the other three after inspecting the results of its 1980, 1984, 1987, and 1990 residential end-use surveys (i.d. at 11-14 and 11-7).

for heat pumps, electric resistance heat, and fossil-fueled heat"¹¹ (Exh. M-1, at 11-8 through 11-14).

(2) Analysis and Findings

To the degree that low response rates could bias MMWEC's estimates, the Department remains concerned by low response rates for MMWEC's survey used to establish baseline saturations. The Department encourages MMWEC to explore reasonable methods of increasing residential customer response rates to ensure that non-response bias is not a factor in its saturation estimates.

Of the four methods currently used by MMWEC to forecast saturations, MMWEC employed three of these methods in its previous forecast. 1990 MMWEC Decision at 16. The Department notes that the fourth method -- the space heating fuel choice model -- could improve the forecast of saturation because it addresses factors related to space heating choices, such as fuel prices and technologies. However, the Department is concerned about the ceiling saturation method for room air conditioning, which may not be empirically based. The Department notes that MMWEC's plan to investigate a quadratic functional form for room air conditioning saturation may improve its current method.

¹⁰(...continued)

¹⁰ MMWEC attempted saturation income regression analysis for room air conditioning and standard freezers (Exh. M-1, at 11-9). In contrast to the high explanatory power of regression results for 16 other appliances, the explanatory power of the regressions for these two appliances was very low (*id.*). MMWEC indicated that, for its next filing, it would investigate a quadratic functional form for room air conditioning saturation (*id.*, at 35-36).

¹¹ MMWEC stated that its space heating fuel choice model follows the logic of similar models used by Oak Ridge National Laboratory and other electric utility forecasting models (Exh. M-1, at 11-10).

For purposes of this review, the Department finds that MMIEC's methodology for forecasting appliance saturations is acceptable.

c. Average Use per Appliance

(1) Description

To estimate average use per appliance type, i.e., kilowatt-hours ("KWH") per appliance type per year, MMIEC established average use for its 1990 base year (Exh. M-1, at 11-14). MMIEC took base year energy use for many appliances from NEPOOL (i.d.).¹² MMIEC identified two major factors affecting its projections of average use per appliance: (1) the price of electricity, and its effect upon consumption as transmitted through price elasticity relationships;¹³ and (2) appliance efficiency trends¹⁴ (i.d. at 11-16 through

¹² For ten appliance types, MMIEC did not use NEPOOL data (Exh. M-1, at 11-15, 16). Instead, MMIEC derived its own estimates for (1) space and water heating, using data from MMIEC members with separate rates for electric water heat and/or space heat customers; (2) ranges, frost free refrigerators and electric clothes dryers, using data from a joint utility monitoring project ("JUMP") including five MMIEC members and five other Massachusetts utilities; (3) supplemental space heaters from the Edison Electric Institute; (4) solar water heaters, well pumps and water beds from MMIEC calculations and estimates; and (5) miscellaneous, as the difference between actual total residential sales and the predicted use of all the other appliances (i.d.).

¹³ Two price elasticity factors for each appliance type incorporate short-term (levels of use) and long-term (efficiency of new equipment) effects, respectively, over the various appliance lifetimes (Exh. M-1, at 11-19). MMIEC used the elasticity factors assumed in NEPOOL's model (Exh. DPU-25). Both types of elasticity are estimated to vary considerably from one appliance type to another, with the long-run elasticity about twice the short-run elasticity for each appliance type (Exh. M-1, at 20).

¹⁴ MMIEC identified reductions in energy use per appliance from 1990 to 2001, ranging from 0.7 percent to 42.3 percent, from appliance efficiency standards applied to 16 appliance types (Exh. M-1, at 11-22).

II-22).¹⁵

MMWEC discussed reasons why a snap-back, or rebound, effect, i.e., responding to efficiency-driven savings on electricity bills by increasing electricity consumption, should be very small compared to electricity use (Tr. 1, at 66-68). MMWEC reported that most researchers who sought to quantify the snap-back effect have failed to detect it (Exh. M-1, at II-21 through II-25).

(2) Analysis and Findings

The Department notes that MMWEC has used more detailed methods to estimate energy use for appliances that are projected to use relatively higher amounts of energy. The Department notes that this represents an appropriate method for MMWEC to allocate its forecasting resources. In addition, the Department notes that MMWEC has employed a sophisticated method involving prices and elasticities to estimate changes in average energy use per appliance type. For purposes of this review, the Department finds that MMWEC's methodology for forecasting average use per appliance is acceptable.

d. Conclusions on the Residential Sector Forecast

The Department's review has found that MMWEC's methodologies for forecasting the number of residential customers, appliance saturations, and average use per appliance type are acceptable. Accordingly, the Department finds MMWEC's residential forecast to be

¹⁵ However, for forecasting changes in miscellaneous appliance use, MMWEC used a regression model linking miscellaneous energy use to number of persons and income per household (Exh. M-1, at II-16).

reviewable, appropriate, and reliable.

4. Commercial Energy Forecast

MMWEC states that its 1991 commercial electric use was 1,144,965 MWH, or 31 percent of total use (Exh. M-3, at 1). MMWEC forecasted a 2.6 percent annual compound commercial growth rate over the forecast period (i.d.).

The structure of the MMWEC commercial energy forecast is the same as in MMWEC's previous filing (Exh. M-1, at 11-27). See 1990 MMWEC Order at 24.

MMWEC forecasted commercial sector energy requirements with a disaggregated end-use methodology (Exh. M-1, at 11-27). MMWEC's commercial model forecasts electricity consumption for four end uses (heating, cooling, lighting, and miscellaneous) across ten building types (office, restaurant, grocery, warehouse, retail, school, college, health, lodging, and other) (i.d. at 11-27). The model calculates energy use as the product of the amount of affected floorspace and the intensity of electricity use per square foot ("EUI") of such floor space (i.d. at 11-32).¹⁶ Electricity consumption is summed across the four end uses and ten building types (i.d. at 11-32, 11-34).

¹⁶ The structure of MMWEC's commercial model reflects considerable complexity. First, floor space is divided into new and existing stock, with a retirement rate of 2 percent per year applied to existing stock (Exh. M-1, at 11-31 through 11-40). Second, electricity service is the product of the saturation (fraction of floor space served by an end use) and electric market share (fraction of the served floor space which is served by electricity) (i.d. at 11-33). Third, electricity use per square foot is the product of electricity service and an EUI for that end use (i.d.). Fourth, EIUs differ for new and existing stock, and from one building type to another (i.d. at 11-34 and 11-40 through 11-45; Exhs. DPU-49; DPU-50).

a. End Uses Modeling Methodology

(1) Description

MMWEC stated that the ten building types are standard classifications used throughout the industry (Exh. M-1, at 11-27). However, MMWEC added that other end uses, notably ventilation, refrigeration, cooking, and water heating, are modeled separately by some utilities (*i.d.* at 11-28). Noting how much energy use was aggregated into MMWEC's miscellaneous end use, the Siting Council directed MMWEC to identify further end uses to disaggregate or to justify the current level of disaggregation. 1990 MMWEC Decision at 27-28. In the current filing, MMWEC did not disaggregate more end uses, but continued to consolidate 45 to 50 percent of commercial energy use into the miscellaneous category (Exh. DPU-50, at 7-8; Tr. 1, at 77). MMWEC's principal justification was that further disaggregation does not guarantee a more accurate forecast (Exh. M-1, at 11-28). MMWEC argued that "[u]nless the driving exogenous variables can be forecast accurately, it is possible that additional disaggregation of structural models may actually reduce overall forecast accuracy" (*i.d.*).¹⁷ MMWEC stated that there was far less agreement among utilities on EUI values for ventilation, refrigeration, water heating, and cooking than for the end uses MMWEC disaggregated (heating, cooling, lighting) (*i.d.* at 11-28, 11-29).¹⁸

¹⁷ However, MMWEC admitted that further disaggregation might improve forecast accuracy, since different end uses can be expected to grow at different rates (Tr. 1, at 80-84). MMWEC added that more disaggregation might serve conservation program goals more than commercial forecasting goals (*i.d.* at 88-89).

¹⁸ MMWEC provided data to show greater variation in estimated EUIs among utilities for water heating, refrigeration and cooking (Exhs. M-1, at 11-29; DPU-34). However, MMWEC had no relevant data on ventilation (Exh. DPU-32).

MMWEC estimated that it would cost \$10,000 to modify its computer code to accommodate additional end uses and \$250,000 to acquire reliable audit-based data on such end uses (Exh. DPU-35). MMWEC explained that secondary data on hand would be lower in cost but less reliable than audit data, and stated that it preferred secondary data if more disaggregation is required (Tr. 1, at 91-92; Exhs. DPU-48; M-1, at 11-29).

(2) Analysis and Findings

The Department notes its concern that "consolidating numerous end-uses into a large miscellaneous category defeats the purpose of a disaggregated end-use model." See 1990 MMWEC Decision at 27. On the other hand, the Department recognizes that more disaggregation could require a substantial investment on the part of MMWEC. The greater forecast precision which could result from a greater degree of end-use disaggregation in MMWEC's commercial sector must be weighed against the cost of achieving it. The record shows that there is more variability among EUI estimates for three end uses that MMWEC aggregates, compared to ones that MMWEC disaggregates. Based on the record in this case, the Department cannot at this time resolve the question of how much commercial end-use disaggregation is appropriate for MMWEC. Therefore, the Department makes no finding about whether the set of commercial end uses modeled by MMWEC is acceptable. In order to approve MMWEC's commercial end use modeling methodology, in its next filing MMWEC must provide the Department with sufficient information for this question to be resolved.¹⁹

¹⁹ The Department notes that MMWEC's peak load forecast methodology produced
(continued...)

b. Floor Space

The floor space component of MMWEC's commercial model produced annual estimates of floor space by building type for both new and existing buildings (Exh. DPU-50). Major data inputs for floor space estimates were (1) base year floor space estimates by building type, based on MMWEC's 1987 Commercial Mail Survey, and (2) employment trends²⁰ from the economic forecast (Exh. M-1, at 11-36) (see Section 11.C.1, above). Based on its review of the literature, in which researchers discerned no changes in historical floor space per employee ratios, MMWEC estimated floor space for each building type as the product of the base year floor space and the relative change in employment, compared to the base year (Exh. M-1, at 11-36 through 11-39).

The Department notes that MMWEC has used appropriate inputs to estimate commercial floor space. The Department notes that a forecast, including a forecast of commercial floor space amounts by building type, typically loses accuracy in later years, as the factors underlying a forecast increasingly change in ways that differ from those assumed in the forecast. The Department encourages MMWEC to consider use of a broader base for estimating floor space, including data collected after 1987. The Department also notes that MMWEC's floor space per employee assumption appears well grounded in empirical studies.

¹⁹(...continued)

forecasts about as accurate as more sophisticated methodologies used by other Massachusetts utilities (RPU2). A similar comparison may prove useful as the basis for comparing accuracy in terms of end use disaggregation in the commercial sector.

²⁰ MMWEC used enrollment in place of employment for schools (Exh. M-1, at 11-36).

Accordingly, the Department finds that MMWEC's commercial floor space methodology is acceptable.

c. End-Use Saturation and Market Share for Electricity

MMWEC stated that end-use saturation rates (i.e., percent of floor space served by electricity) for cooling, lighting and miscellaneous were based on its 1987 Commercial Mail Survey and held constant for the forecast period (Exh. M-1, at 11-40).²¹ MMWEC stated that it determined the portion of new floor space heated with electricity with a fuel choice model (i.d.). MMWEC assumed that 100 percent of new floor space would have lighting and miscellaneous energy use (Exh. DPU-50).

The Department notes that MMWEC has used appropriate inputs into estimated saturations and market share for electricity. The Department again notes that forecasts, including forecasts of commercial end-use saturations and electricity market share by end use, typically lose accuracy in later years, as the factors underlying the forecasts increasingly change in ways that differ from those assumed in the forecasts. The Department encourages MMWEC to use a broader base for estimating end-use saturations and electricity market share by end use, including data collected after 1987.

The Department finds that MMWEC's methodologies for end-use saturation and market share for electricity are acceptable.

²¹

A 1988 Commercial and Industrial Survey for MMWEC estimated saturation and electricity market share separately, by building type, resulting in estimates similar to its 1987 Commercial Mail Survey (R-DPU-8). The 1988 survey also estimated saturation and market shares by fuel for space heat (i.d.).

d. End Use Intensities

(1) Description

In its model, MMIEC derived end-use electricity intensities ("EUIs"), measured in KWH per square foot of floorspace,²² for new buildings and existing buildings (Exh. M-1, at 11-28, 29, 34). For existing buildings, MMIEC derived EUIs from the Massachusetts inputs to NEPOOL's commercial model and EUIs currently used by other Massachusetts utilities,²³ choosing among them based on its consultant's recommendations (*i.d.* at 11-40; Exh. DPU-49). For new buildings, MMIEC derived EUIs from regional utility averages of engineering simulation analyses based on prototypical buildings (Exh. M-1, at 11-40). MMIEC stated that it developed prototypical building parameters from its 1987 Commercial Mail Survey (*i.d.*).

MMIEC estimated that EUIs would remain constant for heating, cooling and lighting, but that miscellaneous use would increase 1 to 3 percent per year (*i.d.* at 11-46; Exh. DPU-50). The estimated EUIs for most building types were generally somewhat lower for new buildings than for existing ones, especially for heating but rarely for miscellaneous use (Exh. DPU-50).²⁴

²² MMIEC stated that floorspace is a reasonable proxy for energy using equipment, since the size of a commercial energy using system (especially heating, lighting, cooling or ventilation) is closely correlated with the amount of floorspace in a structure (Exh. M1, at 11-32; DPU-38; Tr. 1, at 103).

²³ MMIEC stated that estimates of EUIs by various utilities, for a given end use and building type, vary considerably (Exh. M-1, at 11-28, 29).

²⁴ Estimated EUIs in new buildings ranged (by building type) from 1.40 to 13.30 for heating, 0.20 to 4.65 for cooling, 3.60 to 9.20 for lighting, and 1.50 to 33.80 for (continued...)

(2) Analysis and Findings

The Department is concerned that heating EUIs for schools and colleges -- projected as one-third to one-tenth of those for most other commercial building types -- may fall outside a reasonable range of variation. The Department recognizes that estimates of EUIs for a given end use and building type may vary considerably, depending upon the source and the methodology from which the estimates were derived. At the same time, the Department recognizes that EUIs are a critical component of MMWEC's commercial forecasting methodology. The Department encourages MMWEC to examine its estimates of EUIs, particularly those of schools and colleges. For purposes of this review, the Department finds MMWEC's methodology for calculating EUIs is acceptable.

e. Conclusions on the Commercial Sector Forecast

The Department has made no finding about the acceptability of the set of end uses modeled by MMWEC. The Department has found MMWEC's methodologies for estimating floor space, end use saturation and market share, and EUIs to be acceptable. Accordingly, the Department finds MMWEC's commercial energy forecast to be reviewable, appropriate, and reliable.

5. Industrial Energy Forecast

MMWEC stated that its 1991 industrial electric use was 868,127 MWh, or 23

²⁴(...continued)

miscellaneous (Exh. DPU-50). For existing buildings, they ranged from 3.60 to 16.70 for heating, 0.20 to 4.65 for cooling, 4.00 to 10.10 for lighting, and 1.50 to 33.80 for miscellaneous (i.d.). Heating EUIs for schools and colleges were only a third to a tenth of those for most other building types (i.d.).

percent of total use (Exh. M-3, at 1). MMWEC forecasted a 2.4 percent annual compound industrial growth rate over the forecast period (i.d.).

The structure of MMWEC's industrial energy forecast is similar to the structure in MMWEC's previous filing (Exh. M-1, at 11-49). See 1990 MMWEC Decision at 30. MMWEC forecasted industrial energy consumption as the sum of consumption by 19 two-digit SIC industries (Exh. M-1, at 11-49).²⁵ Forecasts for each SIC are the product of (1) forecast employment, (2) base year electric use per employee, and (3) changes in electric use per employee (Exh. M-1, at 11-50). MMWEC's employment forecast is discussed in Section III.C.1 above.

a. Base Year Electric Use per Employee

In order to construct estimates of base year electricity use per employee, MMWEC divided billing data for selected industrial accounts by manufacturing employment (Exh. M-1, at 11-50).²⁶ In this way, MMWEC developed three-year moving averages as the basis for base year energy intensity for each industrial SIC (i.d. at 11-50). MMWEC asserted that multi-year moving averages, as opposed to single-year data, would increase the stability

²⁵ The only noteworthy difference between the current and previous MMWEC industrial forecast methodologies is that the previous forecast was the sum of industrial sector forecasts for each individual MMWEC member each using the same methodology as MMWEC's current forecast (Exh. M-1, at 11-50 through 11-52). See 1990 MMWEC Decision at 30.

²⁶ In the process of matching billing data to employment data, beginning in June 1992 MMWEC revised the assignments of many accounts from one SIC to another SIC, based on more complete 1990 employment data from MDET (Exh. DPU-56). This reclassification led MMWEC to revise its filing for industrial sales by SIC (i.d.; Exh. M3, at 5). Consequently, for several industrial SICs, 1991 sales figures changed by a factor of two or more; however, overall industrial sales remained stable (i.d.).

and reliability of its forecast (i.d. at 11-51).

The Department notes the key role of empirical data specific to the MMWEC system in this aspect of its industrial forecast methodology. The Department commends MMWEC for its review of classification of industrial facilities to SICs and its use of multi-year moving averages as a means of increasing the stability and reliability of the base year electric intensity estimates. Based on the foregoing, the Department finds that MMWEC's base year electric use per employee methodology is acceptable.

b. Changes in Electric Use per Employee

(1) Description

MMWEC referred to changes in electric use per employee as electric intensity or energy intensity (Exh. M-1, at 11-51). Specifically, MMWEC stated:

The intensity of use measures changes in industrial electric use per employee over time resulting from price and technological changes. Trends in energy intensity were extracted from the Massachusetts industrial models supported by NEPLAN. These trends are forecast using an assortment of econometric models estimated for NEPLAN by National Economic Research Associates ("NERA"). The Massachusetts models, including translog and dynamic functional forms, were estimated at the two-digit level. Use intensity trends for each SIC industry were developed to reflect MMWEC's future price of electricity through econometrically estimated elasticities of demand (i.d.).

MMWEC used regional energy intensity trends rather than individual member trends, based on its conclusion that regional trends would reflect future intensity changes on a more comprehensive basis (i.d. at 11-52).

MMWEC stated that it used three types of equations, developed by NERA, to

forecast intensities: (1) a translog form for seven SICs;²⁷ (2) a dynamic form for six SICs;²⁸ and (3) another, unnamed, form for five SICs²⁹ (Exh. DPU-53). NERA reported that the equations were estimated using annual state-level data from six states, covering nine years during the 1973-1984 period, for each of the 18 industries (RR-DPU-11, Att. 3, at 22). MMWEC also provided NERA's analysis and derivation of price elasticities by SIC (RR-DPU-11, Att. 3, 4).

MMWEC specified the translog equations used for seven SICs (RR-DPU-11, Att. 3, at 16-19, Tables 7-20 through 7-39). These seven translog equations were linear functions of the logarithms of SIC output, the prices of labor, capital, materials, electricity and other fuels, and their interactions (Exh. DPU-53; RR-DPU-11, 3, at Tables 7-20 through 7-39). MMWEC reported that from ten to 18 coefficients were statistically significant for each of the seven equations (RR-DPU-11, 3, at Tables 7-20 through 7-39).³⁰

The dynamic equations which MMWEC used for six other SICs were functions of:

²⁷ The seven industries are food, lumber, leather, stone, fabricated metal, machinery, and miscellaneous (Exhs. DPU-53; M-1, at 11-49). Together, these seven SICs account for 29 percent of 1991 industrial sales by MMWEC members (Exh. M-3, at 5).

²⁸ The six industries are clothing, furniture, paper, chemicals, primary metal and vehicles (Exhs. DPU-53; M-1, at 11-49). Together, these six SICs account for 28 percent of 1991 industrial sales by MMWEC members (Exh. M-3, at 5).

²⁹ The five industries are textiles, printing, chemicals, electric machinery, and instruments (Exhs. DPU-53; M-1, at 11-49). Together, these five SICs account for 43 percent of 1991 industrial sales by MMWEC members, including 29 percent sold to the electric machinery industry (Exh. M-3, at 5).

³⁰ MMWEC also reported coefficients of translog equations for ten of the other eleven SICs where it chose not to use translog equations (RR-DPU-11, Att. 3, at Tables 7-23 through 7-38). Among these were 36 coefficients involving output, all but four of them significant, and 94 involving various prices, all but seven of them significant (id).

current and lagged electric use; current and lagged output of the industry; prices and shares of labor, capital, materials, electricity and other fuels; and a dummy variable for Massachusetts (Exh. DPU-53; RR-DPU-33, Att. 5). Some of the coefficients for these variables were significant.³¹

MMWEC claimed that the equations it used for the five other SICs were functions of SIC output, a time trend, and the price of electricity (Exh. DPU-53). MMWEC provided no empirical derivations of the five equations, nor any measures of statistical significance for any of them or for any variable in any of them (RR-DPU-33).

(2) Analysis and Findings

The Department notes that the most recent data underlying the equations for electric intensity is now ten years old. For the reasons discussed above for the commercial sector, more recent data could be expected to improve the accuracy of the industrial forecast as well. The Department encourages MMWEC to ensure that it is using the most appropriate vintages of data in estimating the coefficients of its equations when forecasting industrial sector electricity intensity.

The Department notes that the translog equations employed by MMWEC appear to account for appropriate explanatory factors in statistically significant ways. However, the

³¹ Equations for four of the SICs explained almost all of the variation in past electricity sales, but two of the equations (SICs 26 and 3) explained only about two-thirds of the variation (RR-DPU-11, Att. 3, at Table 10). For each of the six equations, the adjustment factor was statistically significant and the state dummy variable was not (*i.e.*, the constant term was significant in all but one equation, but no statistical measures were reported for two other important parameters: long-run price elasticity and factor output elasticity (*i.d.*, Att. 3, Tables 9 and 10).

Department notes that the numbers of variables (ten to 19) used are large relative to the number of observations (54), a relationship which may lead to modest overstatement of the true statistical significance of results, but not to bias in the coefficients. The Department accepts MMWEC's methodology for forecasting electricity intensity in seven SICs.

The Department notes that the dynamic form employed by MMWEC for six SICs accounts for appropriate explanatory factors, many of them in statistically significant ways. The Department notes that MMWEC has provided measures of statistical significance for some sets of price elasticities, but that these were omitted for others. The Department encourages MMWEC to explore the statistical significance of elasticity on a comprehensive basis. Here, the Department accepts MMWEC's dynamic equations methodology for forecasting electricity intensity in six SICs.

With respect to the equations for the five SICs representing 43 percent of industrial sales, MMWEC has provided little detail regarding key points of information. Specifically, measures of statistical significance for these five equations were omitted. Thus, the Department makes no finding regarding the acceptability of the forecasting methodology for the five SICs. In order to approve MMWEC's forecast of changes in electricity use per employee in its next filing, MMWEC must furnish a full explanation of its industrial forecast methodology including complete statistical performance information for all SICs forecast.

C. Conclusions on the Industrial Sector Forecast

The Department has accepted MMWEC's (1) base year electricity use per employee methodology; (2) translog methodology for forecasting changes in electricity use per employee for seven SICs; and (3) dynamic methodology for forecasting changes in electricity

use per employee for six SICs. The Department has made no finding regarding the acceptability of MMWEC's methodology for forecasting five SICs which represent 43 percent of industrial sales. Accordingly, based on the foregoing, the Department finds MMWEC's forecast of industrial energy to be minimally reviewable, minimally appropriate, and minimally reliable.

1. Forecast for Municipal, Street Lighting, and Other Energy

MMWEC stated that the electricity use for municipal, street lighting and other energy in 1991 was 135,087 MWH, or 4 percent of total use (Exh. M-3, at 1).³² MMWEC forecasted a 0.7 percent annual compound growth rate over the forecast period for these uses (*id.*).

MMWEC stated that its revised forecast of these energy uses was proportional to the number of residential customers (Exh. DPU-61; Tr. 1, at 126). This revision was a change from use of regression equations for the three uses in MMWEC's filing (Exh. M-1, at 11-53; Tr. 1, at 18). MMWEC explained that it revised its methodology because the regression equations produced implausible results (Tr. 1, at 18). Specifically, MMWEC stated that its new forecast, in contrast to the forecast based on the regression equations, excluded data from former MMWEC members (*id.* at 127).³³

The Department notes the reasonableness of MMWEC's revised methodology because

³² In addition, 268,947 MWH (7 percent) of electricity sent out to all kinds of customers was lost as heat (Exh. M-3, at 1). MMWEC forecast such losses to grow at about the same rate as electricity sent out (*id.*).

³³ MMWEC's data show that, after rising steadily for eight years, municipal use fell 31 percent from 1989 to 1990 and slightly again in 1991 (Exh. M-3, at 1).

the regression results were based on data from former members and would therefore fail to produce accurate forecasts for current members. Accordingly, the Department finds that MMWEC's methodology for forecasting municipal, street lighting, and other energy to be reviewable, appropriate, and reliable.

D. Conclusions on the Energy Forecast

The Department has found: (1) MMWEC's economic and demographic forecast to be reviewable, appropriate, and reliable; (2) MMWEC's electricity price forecast to be reviewable, appropriate, and reliable; (3) MMWEC's residential forecast to be reviewable, appropriate, and reliable; (4) MMWEC's commercial forecast to be reviewable, appropriate, and reliable; (5) MMWEC's industrial forecast methodology to be minimally reviewable, minimally appropriate, and minimally reliable; and (6) MMWEC's forecast of municipal, street lighting, and other energy to be reviewable, appropriate, and reliable.

In reviewing the demand forecast as a whole, the Department determines that MMWEC continues to demonstrate noteworthy advances in its forecasting methodology. For example, since its last filing MMWEC has implemented (1) an electricity price forecast model which allows prices to rise and fall, (2) fuel choice models for space heating in the residential and commercial sectors, (3) a broader base for estimating initial year electricity use per industrial employee, and (4) a revised classification of industrial firms to better use state employment data. MMWEC also has reviewed empirical studies concerning the snap-back effect, changes in electricity use per commercial employee, and utility estimates of electricity use per square foot of commercial floor space.

Accordingly, on balance, the Department finds that MMWEC's forecast of energy

requirements is reviewable, appropriate, and reliable.

E. Peak-Load Forecast

1. Description

MMWEC indicated that its member utilities' summer peak loads grew from 443 MW in 1976 to 689 MW in 1990, at a compound annual growth rate of 3.2 percent (Exh. M-5, at 1).³⁴ The Company stated that its aggregate forecast of member utilities' non-coincident summer peak loads was projected to grow from 707 MW in 1991 to 858 MW in 2002, at a compound annual growth rate of 1.8 percent (i.d.). The Company stated that its aggregate forecast of member utilities' non-coincident winter peak loads was projected to grow from 659 MW in 1991 to 820 MW in 2002, at a compound annual growth rate of 2.0 percent (i.d.).

MMWEC stated that its aggregate peak load forecast was calculated as the sum of member non-coincident peaks (Exh. M-1, at 11-57). The Company stated that it developed its forecast of peak load by transforming energy demand into peak demand through a characteristic load factor for each member (Tr. 2, at 5).³⁵ MMWEC indicated that it developed seasonal peak load forecasts for each member utility using the energy requirements forecasts described above and the average of the seasonal load factors that applied to each member utility from the years 1986 through 1990 (Exhs. M-1, at 11-57; DPU-9; Tr. 2, at 3).

³⁴ The Department notes that the membership of MMWEC has changed from time-to-time, with resultant changes in the aggregate peak load growth rate.

³⁵ "Load factor" may be defined as the ratio of the average load during a specified period to the maximum load occurring during the same period.

MMWEC's witness, Mr. Stinson, stated that MMWEC developed high- and low-case bandwidths for its peak load forecast (Tr. 2, at 18). The Company indicated that high and low growth scenarios were constructed through model executions utilizing high and low input assumptions for the major energy forecast drivers, including demographic, economic, and price of electricity inputs (i.d.). See Sections III.C.1 and III.C.2 for discussions relative to the models and data sets used to develop MMWEC's base-case economic, demographic, and electricity price forecasts.

MMWEC indicated that it constructed the high-case peak load bandwidth by (1) utilizing the actual Massachusetts demographic growth trend from the 1976-to-1991 period, (2) utilizing DRI's Fall, 1992 high-case forecast of Massachusetts employment, and (3) reducing the base-case electricity price forecast by 0.5 percent per year (Exh. DPU-13). MMWEC further indicated that it constructed the low case peak load bandwidth by (1) reducing the projected annual population growth rate by 50 percent, (2) utilizing DRI's Fall, 1992 low case forecast of Massachusetts employment, and (3) increasing the base electricity price forecast in real terms by 1.5 percent per year (i.d.). The Company indicated that it did not conduct a formal analysis of the probabilities that the high- and low-case peak load scenarios would occur (Tr. 2, at 20).

The Company stated that it considered, and rejected the possibility of developing and implementing an alternative peak load forecasting methodology that included the disaggregation of end-uses (i.d. at 5-6). MMWEC stated that its aggregated, load factor model achieved a level of accuracy that was comparable to other electric utilities in New England that employ a disaggregated end-use peak load forecasting approach (i.d. at 6-7;

RR-DPU-13, at 1). MMWEC further stated that implementing a disaggregated end-use peak load forecasting methodology would involve (1) development of "load shapes" for specific end-uses, and (2) calibration of the load shapes to individual municipal system load profiles (Tr. 2, at 7). MMWEC stated that such an effort would be time-consuming and expensive (*id.*). The Company stated that, while a disaggregated peak load forecasting approach may offer greater analytical flexibility, it would pose great difficulties given the constraints on MMWEC's budget and staffing resources (RR-DPU-12, at 4). MMWEC added that key determinants of peak load, including weather effects, future trends in peak load attributable to specific end-uses, and changes in socioeconomic and demographic factors are reflected in its energy requirements forecasts and its load factor averaging process (*id.* at 17; Exh. DPU-14). The Company indicated that it rejected the possibility of implementing an alternative peak load forecasting methodology, and concluded that the load factor approach used to develop its peak load forecast was an adequate methodology (Tr. 2, at 6, 9).

2. Analysis and Findings

In the past, the Sitting Council has approved load factor methodologies similar to MMWEC's. See Eastern Utilities Associates, D.P.U. 92-214, at 35 (19__); Nantucket Electric Company, 21 DOMSC 208, 253 (1991) ("1991 Nantucket Decision"); 1990 MMWEC Decision at 37-39. However, the Department and the Sitting Council have also stated that end-use peak load modeling is essential in order to capture the underlying factors (e.g., weather effects, energy efficiency improvements, changes in socioeconomic and demographic factors, and varying consumption patterns during different months, days and hours) that contribute to peak load. Eastern Utilities Associates, *supra* at 34;

1990 MMWEC Decision at 38-39. The Siting Council and the Department also have noted that aggregate approaches, such as that employed by MMWEC, are not well-suited for analyzing and responding to structural changes in end-use capabilities. Id.

The Department notes that MMWEC has made progress in disaggregating its energy requirements forecasts, and that these energy forecasts are key inputs into the Company's peak load forecast. However, while these improvements to the energy requirements forecasts may be viewed as enhancements to the peak load forecast, the disaggregation of the energy forecasts is not clearly reflected in the peak load forecast because the energy forecasts are essentially re-aggregated before they are applied to the historical average load factors. Therefore, the Department encourages MMWEC to explore the possibility of disaggregating its peak load forecasting methodology.

The Department notes that MMWEC's development of peak load forecast bandwidths represents a significant enhancement to the forecast. Forecast bandwidths can provide valuable information regarding outcomes under a range of forecast scenarios. However, the Department notes that MMWEC did not conduct an analysis of the probabilities that alternative scenarios would actually occur. Without such an analysis, it is difficult to discern the plausibility of the alternative scenarios used to develop the forecast bandwidths. Therefore, the Department encourages MMWEC to conduct statistical analysis of the scenarios used to construct the peak load forecast bandwidths.

Despite the lack of disaggregation of MMWEC's peak load forecasting methodology, the Company has enhanced the forecast through improvements in the energy requirements forecasts and the development of peak load forecast bandwidths. Accordingly, the

Department finds MMWEC's peak load forecast to be reviewable, appropriate, and reliable.

3. Compliance with Directive Twelve Regarding MMWEC's Peak Load Forecast

In the previous review of MMWEC's peak load forecast, the Siting Council directed MMWEC to develop and present an analysis of alternative peak load forecasting methodologies, including (1) the ability of each alternative methodology to reflect the major underlying factors of peak load, (2) the level of disaggregation achieved by each alternative methodology, and (3) a time schedule for implementing improvements to MMWEC's peak load forecasting methodology. 1990 MMWEC Decision at 39. The record in this case indicates that MMWEC analyzed alternative peak load forecasting methodologies, including (1) the ability of each alternative methodology to reflect the major underlying factors of peak load, and (2) the level of disaggregation achieved by each alternative methodology. The record in this case further indicates that MMWEC has implemented improvements to its peak load forecasting methodology, including the development of bandwidths to analyze potential outcomes under a range of forecast scenarios. Accordingly, the Department finds that MMWEC has complied with Directive Twelve regarding the Company's peak load forecast.

F. Conclusions on the Demand Forecast

The Department has found that MMWEC has complied with Orders 1-7 and 9-12 of the 1990 MMWEC Decision. The Department has noted that MMWEC addressed Order 8, but the Department needs more information from MMWEC in its next filing.

The Department has found that MMWEC's energy forecast to be reviewable, appropriate, and reliable. The Department has also found that MMWEC's peak load forecast

to be reviewable, appropriate, and reliable. Accordingly, the Department hereby APPROVES MMWEC's 1992 demand forecast.

IV. ANALYSIS OF THE SUPPLY PLAN

A. Standard of Review

Because we have established a new standard for reviewing MMWEC's supply plan (see § II.C supra), we will restate that standard here before beginning our discussion of the Company's supply plan. As stated, in keeping with its mandate in G.L. c. 164, § 69H, to "provide a necessary energy supply for the commonwealth with a minimum impact on the environment at the lowest possible cost," the Department reviews two dimensions of MMWEC's supply plan: adequacy and cost.

The adequacy of supply is a utility's ability to provide sufficient capacity to meet its peak loads and reserve requirements through the forecast period. Cambridge Electric Light Company, 12 DOMSC 39, 72 (1985); Boston Edison Company, 10 DOMSC 203, 245 (1984). With respect to the adequacy of MMWEC's supply plan, MMWEC must demonstrate that the Company and its members in aggregate own or have under contract sufficient resources to meet projected, aggregate capability responsibility throughout the forecast period, or that MMWEC operates according to a specific action plan to meet this responsibility.

Regarding cost, MMWEC must demonstrate that it has identified and demonstrated the cost-effectiveness of a variety of supply options. In order to demonstrate such, MMWEC must show that it has examined a reasonable range of resources to meet its projected aggregate capability responsibility by (1) compiling a reasonable array of available resource

options, and (2) developing and applying appropriate criteria for screening its array of available resource options.

Finally, as part of its supply plan process, MMWEC also must demonstrate that recommended resource options are (1) cost-effective compared to available alternatives, using methods such as competitive solicitations open to all bidders, and (2) not otherwise contrary to the public interest.

B. Previous Supply Plan Review

In the 1990 MMWEC Decision, the Siting Council rejected MMWEC's supply plan and ordered MMWEC to do the following in its next supply plan filing:

1. To fully explain and justify the avoided transmission capacity costs assigned to member systems for economic evaluation purposes, including (a) a complete discussion of the methodology used to derive avoided transmission capacity costs, and (b) a full explanation of how transmission capacity cost differences between members were taken into account by the methodology.

2. To review methodologies which evaluate the economic benefits of C&M options on utility distribution systems, and to report to the Siting Council on the findings of its review.

3. To implement a methodology which includes an adequate consideration of the environmental impacts of resource options.

Id. at 98-99. With respect to Order 1, the Department recognizes the member-specific nature of this Order, which would fall outside the scope of an aggregate filing as submitted by MMWEC and would be less relevant because of the standard of review enunciated above. However, the Department notes that transmission costs can represent an important component of supply planning and decision-making. In addition, due to the new standard propounded herein which establishes a new framework by which to consider MMWEC's supply planning activities, it is not necessary to make a finding with respect to Orders 2 and 3.

C. Supply Planning Process

MMWEC stated that it designed its supply planning process to make available to its member systems a range of resource options sufficient to economically and reliably meet their customers' requirements for electric service (Exh. M-1, at VI -4). MMWEC stated that its supply planning process was divided into seven major activities: (1) load forecasting, (2) identification of future resource requirements, (3) identification of resource options, (4) screening of resource options, (5) optimization, (6) implementation, and (7) contingency planning (*i.d.*). For a discussion of MMWEC's load forecasting activities, see Section III, above. MMWEC's identification of future resource requirements is discussed in this Section. For discussions of MMWEC's activities in identifying and screening resource options, and cost-effectiveness, see Sections III.D and III.E, below.

MMWEC stated that it adjusted its forecasted peak load downward to reflect the impact of planned demand-side management ("DSM") activity and upward to reflect estimated reserve requirements (*i.d.* at VI -6).³⁶ MMWEC reported that it compared its total existing and planned resources to its adjusted peak load demand forecast (*i.d.*). MMWEC then developed a preliminary generation expansion plan to determine the approximate amounts of baseload, intermediate, and peaking capacity required to most economically meet the need projected for additional resources (*i.d.*). MMWEC priced the additional capacity at

³⁶ The Department notes that MMWEC's member systems, as members of the New England Power Pool ("NEPOOL"), are required to carry a margin of reserve requirements sufficient to meet NEPOOL standards. MMWEC itself is not a NEPOOL member, serves no load, and carries no reserves. MMWEC's estimate of required reserves is undertaken on behalf of its members.

market rates, based on generating resources previously identified and screened, in order to calculate avoided costs to screen generating resources and analyze DSM resources (*i.d.*).

MMWEC stated that it acted in some respects as a consultant to its members, by screening resource options and reporting back to interested members the identity and characteristics of those options which scored well using MMWEC's screening criteria (Tr. 3, at 47-55). However, MMWEC reported that its members also arrange transactions for power independently, without MMWEC involvement (*i.d.* at 51-52, 59). Similarly, MMWEC noted that members operate independently with respect to recommended DSM programs (*i.d.*, at 97). Specifically, members are concerned about subsidizing commercial and industrial customers (*i.d.*). Mr. Boudreau explained that members reported concerns with use of tax-exempt debt to install DSM in non-exempt entities, *i.e.*, profit-making operations (*i.d.* at 30; Tr. 4, at 119).

D. Adequacy of the Supply Plan

1. Base Case Supply Plan

The adequacy period for MMWEC's supply plan encompasses the forecast period, *i.e.*, 1992-2002. The data shown in Table 1 compare the MMWEC system's projected resource capability to its peak load capability responsibility over the forecast period. These data indicate that MMWEC is projecting a capability situation ranging from a surplus of 21 percent in the summer of 1993 to a deficit of 14.6 percent in the summer of 2002 (Exh. M-5, at 1).

2. Adequacy Analysis

a. Assessment of Supply-Demand Balance

MMIEC assessed the adequacy of its planned supplies in meeting its forecasted demand by conducting a probabilistic risk analysis using uncertainties for three types of variables: (1) projected peak load; (2) reserve requirement; and (3) on-line date for planned purchases (Exh. M-1, at VI -9). The projected peak loads in 1995 and 1996 (with various probabilities attached) ranged from 730 MW to 785 MW (i.d. at VI -24, VI -25, VI -26). The projected reserve margins (with various probabilities attached) ranged from 13 percent to 20 percent (i.d. at VI -27). The on-line date probabilities for four units (Masspower, L'Energia, Sterling, and Newbay) took on various values for four different years and for "Never" (i.d. at VI -28).³⁷ MMIEC's analysis showed a zero probability that it would have no more than a 40 MW deficiency or surplus for capacity in 1995 or 1996, and a probability of 52 percent that MMIEC would have some surplus (Exh. M-5, at 1).³⁸

³⁷ MMIEC revised its probabilities during the course of the proceeding, reporting that Masspower and L'Energia were now on-line and Sterling was terminated (Tr. 3, at 6). MMIEC indicated that several MMIEC members and other utilities were negotiating a Newbay contract buyout (i.d. at 83). The Department notes that, since the close of hearings, some MMIEC members and other utilities petitioned the Department for approval of a settlement in the form of contract buyouts. On May 2, 1994, the Department approved the terms of the Newbay buyout in D.P.U. 88-265.

³⁸ MMIEC reported that contracts to purchase power from Northeast Utilities, Point Lepreau in New Brunswick, and Canal, together representing 16 percent of MMIEC's available capacity, would expire before the end of the forecast period (i.d. at VI -10, VI -14, VI -15). Mr. Boudreau stated that MMIEC has been offered extensions of these contracts on favorable terms, but has not decided whether extending those contracts is its most cost-effective option (Tr. 4, at 69-70).

b. MMWEC's Position in the Power Market

MMWEC characterized the power market as a buyer's market, with significant opportunities to purchase from existing generating units at substantially discounted prices (Tr. 3, at 51, 55). Mr. Boudreau claimed that in the current buyers' market, the short term may be ten minutes rather than four years, so that a phone call requesting power at a reasonable price covers any contingency (i.d. at 62-63). MMWEC reported a relatively large amount, 323 MW, of currently unsold non-utility generator ("NUG") capacity, as well as many offers to sell electricity at attractive prices from the two largest utilities in New England and two of the largest utilities in New York (RR-DPU-28, RR-DPU-31). In addition, MMWEC reported offers from eleven different utilities to sell over 2,000 MW of system power and power from individual units for baseload, intermediate, and peaking needs (Exhs. M-1, at VI-19, VI-20; DPU-141; RR-DPU-28). MMWEC also reported more than 40 offers to sell electricity from NUGs with more than 6,000 MW of capacity to sell (Exhs. M-1, at VI-19, VI-20; DPU-141). MMWEC has shown that if it merely extended current contracts for Point LePreau, Canal 2, and Northeast Utilities ("NU") slice-of-system on the same terms, it would show no capacity deficiency until 2001 (Exhs. M-1, at VI-14; M-5, at 1).

c. Conclusions on Adequacy

Pursuant to the standard of review enunciated above, in order to establish adequacy of the supply plan MMWEC must demonstrate that the Company and its members in aggregate own or have under contract sufficient resources to meet projected, aggregate capability responsibility throughout the forecast period, or that MMWEC operates according to a

specific action plan to meet this responsibility. Although MMWEC projects deficiencies beginning in 1997, the Department finds that MMWEC's probabilistic analysis is an appropriate methodology for analyzing multiple contingencies associated with supply planning adequacy. In addition, MMWEC has demonstrated that there is little likelihood that it would experience a significant shortfall in resources in the early years of the forecast period, and that substantial amounts of capacity are likely to be available over the forecast period from numerous sources under current projections.

Based on the foregoing, the Department finds that MMWEC operates pursuant to a specific action plan which will enable it to meet its capacity responsibility over the forecast period. Accordingly, the Department finds that MMWEC's supply plan is adequate to meet its capacity responsibility over the forecast period.

E. Cost Analysis

Regarding the cost aspect of MMWEC's supply planning processes, MMWEC must demonstrate that it has examined a reasonable range of resources to meet its projected aggregate capacity responsibility by (1) compiling a reasonable array of available resource options, and (2) developing and applying appropriate criteria for screening its array of available resource options. In addition, MMWEC must demonstrate that recommended resource options are (1) cost-effective compared to available alternatives, using methods such as competitive solicitations open to all bidders, and (2) not otherwise contrary to the public interest.

1. Identification of Resource Options

MMWEC identified for consideration several types of generation options and an array

of DSM resource options. The Department focuses its review here on whether MMWEC examined a reasonable range of resources to meet its projected aggregate capability responsibility by (1) compiling a reasonable array of available resource options, and (2) developing and applying appropriate criteria for screening its array of available resource options.

a. Available Resource Options

In order to determine whether MMWEC compiled a reasonable array of available resource options, the Department must determine whether MMWEC compiled adequate sets of available resource options for each type of resource identified during this proceeding.

(1) Types of Resource Sets

MMWEC identified the following five types of resource sets for consideration in the supply planning process: (1) purchases of power from other utilities; (2) purchases of power from NUGs; (3) new MMWEC generation; (4) emerging technologies; and (5) DSM options (Exhs. M-1, at VI -6, VI -7; DPU-73, DPU-129, DPU-132).³⁹ MMWEC reported that developers or utilities sometimes contacted member systems who generally then contacted MMWEC, which in turn added the resource offered to its list of options (Exh. DPU-133). MMWEC stated that it had identified no candidates for life extension, since none of its generation units were scheduled for retirement over the forecast period (Exhs. DPU-75, DPU-121).

³⁹ The Department notes that overlap may take place within the identified resource sets. For example, a wind power project could be considered an emerging technology to be acquired either by a NUG purchase or by direct MMWEC- or municipal-financing.

The Department finds that MMMEC has identified reasonable types of resource sets.

(2) Compilation of Resource Sets

(a) Other Utilities

MMMEC reported offers from eleven different utilities to sell power on various terms (Exhs. M-1, at VI -19, VI -20; DPU-141; RR-DPU-28). These utilities included Northeast Utilities, New England Power, New Brunswick Power, Niagara Mohawk, New York State Electric & Gas, Boston Edison, Central Maine Power, United Illuminating, Maine Public Service, Commonwealth Electric, and Green Mountain Power (*i.d.*). The offers included system power and power from individual units, as well as offers for baseload, intermediate, and peaking capacity (*i.d.*). A partial listing of utility offers from individual units totalled more than 2,000 MW (*i.d.*). Since MMMEC has included a wide range of potential power purchases from other utilities, including sources from diverse geographical locations, the Department finds that MMMEC compiled an adequate resource set of purchases from other utilities.

(b) NUGs

Although MMMEC itself issued no RFP soliciting proposals for generation resources since its last forecast and supply plan filing,⁴⁰ MMMEC reported more than 40 offers to sell electricity from NUGs with more than 6,000 MW of capacity to sell (Exhs. M-1, at VI -19, VI -20; DPU-141). These offers included shares in two projects of more than 1,300 MW each, one to be fired by gasified coal and the other by natural gas (*i.d.*). Most of

⁴⁰ However, Mr. Boudreau reported that some MMMEC members did issue RFPs for generation resources (Exh. DPU-76).

the other NUG offers were for projects to be fired by natural gas, with several to be fired by coal, and a few by wood or other renewable resources (including trash and landfill gas) (i d.). Approximately three-fourths of the NUG offers were for electricity from cogeneration projects (i d.). Since MMWEC has included a wide range of potential power purchases from NUGs, including cogenerators and a diversity of fuel types, the Department finds that MMWEC compiled an adequate resource set of purchases from other NUGs.

(c) New MMWEC Generation

MMWEC stated that it had explored the possibility of expanding its own intermediate and peaking generating units at Stony Brook, as well as building a high-pressure gas supply pipeline to Stony Brook (Exh. DPU-127; Tr. 3, at 31; Tr. 4, at 72-74). MMWEC stated that it also analyzed sites offered by six individual MMWEC members for peaking and combined cycle capacity, as well as peaking units offered by three municipal light systems and one generic site (Exhs. DPU-130, DPU-132; Tr. 4, at 72-73). The Department finds that MMWEC has compiled an adequate resource set of new MMWEC- and municipal-owned generation.

(d) Emerging Technologies

MMWEC stated that, using NEPOOL information, it monitored cost and performance data for 13 types of emerging technologies, including three types of nuclear plants, two types of coal-fired plants, three energy storage technologies, four types of renewable technologies, and fuel cells (Exh. DPU-129). MMWEC reported that NUGs offered several renewable

energy technologies (including wood, landfill methane, and trash, but not wind⁴¹ or solar), as well as a fuel cell (Exh. DPU-130). The Department notes that MMWEC has not analyzed specific proposals for electricity from non-fuel resources such as hydro, wind, or solar. For purposes of this review, the Department finds that MMWEC has compiled an adequate resource set from emerging technologies. However, the Department notes that a stronger set of emerging technologies would have included technologies such as hydro, wind, and solar.

(e) DSM Options

MMWEC stated that it identified 57 technologies for consideration in its DSM resource set, based on a 1988 study (Exh. DPU-73, at 5-7). MMWEC reported that its DSM options encompassed six load shape objectives: peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, and flexible load shape (*i.d.* at 2). The 1988 study identified 23 residential technologies and 34 commercial/industrial ("C/I") technologies (*i.d.* at 3-4). Among the technologies were ten involving lighting, nine for efficiency improvements to various kinds of equipment, seven involving direct load control of equipment, six kinds of rates related to the time of electricity use, and four employing energy storage (*i.d.*).

The Department notes that MMWEC's set of DSM technologies is very similar to the DSM technologies actually implemented by other electric utilities in Massachusetts. In that

⁴¹ MMWEC reported that about one tenth of one percent of capacity is individually owned by its members (but about one hundredth of one percent of total MMWEC capacity entitlements) consists of a municipal wind farm in Princeton, Massachusetts (Exh.M1, at IV-30, IV-31).

MMWEC has presented an extensive number of DSM technologies for this resource set, and has considered technologies actually in use by other utilities in the area, the Department finds that MMWEC has compiled an adequate set of DSM resources.

(3) Conclusions on Available Resource Options

The Department has found that MMWEC has identified a reasonable range of resource sets. The Department has also found that MMWEC compiled an adequate set of power purchases from (1) other utilities, (2) NUGs, (3) new MMWEC generation, (4) emerging technologies, and (5) DSM options. Accordingly, the Department finds that MMWEC has demonstrated that it compiled a reasonable array of available resource options.

b. Development and Application of Screening Criteria

To determine whether MMWEC developed and applied appropriate criteria for screening its array of available resource options, the Department reviews the criteria developed and applied to MMWEC's resource sets. Thus, the Department reviews the criteria that were developed and applied to MMWEC's five identified resource sets: (1) purchases of power from other utilities; (2) purchases of power from NUGs; (3) new MMWEC generation; (4) emerging technologies; and (5) DSM options.

In general, MMWEC's screening process considered cost and non-cost aspects of available resource options (Exh. M-1, at VI -6, VI -7). MMWEC applied different sets of non-cost criteria to DSM resources from those which it applied to generation resources (*id.* at VI -8; Exhs. DPU-73; DPU-79). In its filing, MMWEC stated that its major cost criterion was avoided cost, and that this criterion was applied to both generation and DSM options (Exh. M-1, at VI -6).

However, MMWEC reported that avoided costs have declined substantially since its previous filing (Tr. 3 at 47, 55, 109; RR-DPU-18). Moreover, MMWEC stated that it incorporated feedback from supply-side prices reported in the market to periodically revise its avoided costs (Tr. 3, at 73-75). Specifically, if all the generation resources screened were priced significantly below the calculated avoided cost, MMWEC revised the avoided cost downward to reflect the actual cost avoided, while if they were all significantly higher, MMWEC revised its avoided cost upward (i.d.). In practice, more recently MMWEC and its members have directly compared the costs of the various generation resources offered to one another to determine the lowest cost resources, without resorting to an avoided cost comparison; the costs of the resources were then weighed against the non-cost characteristics of those same resources (i.d. at 59-60, 149).

Below, the Department addresses MMWEC's development and application of screening criteria for supply-side and demand-side resources.

(1) Supply-Side Resources⁴²

MMWEC analyzed proposed generation resources (owned by other utilities, NUGs, or MMWEC or its members) by ranking three aspects of projects on a scale from 0 to 100: (1) viability; (2) benefits and risks; and (3) compliance with strategic goals and objectives (Exh. M-1, at VI-7). MMWEC stated that for it to recommend a project to its members, the project would need to score well in each of the three aspects (Tr. 4, at 79-80, 107-108).

⁴² This section discusses MMWEC's supply-side resource sets. Specifically, these resources are power purchases from (1) other utilities, (2) NUGs, and (3) new MMWEC generation.

Each of the three aspects in turn was rated according to seven or eight factors (Exh. M-1, at VI -8).

Factors used to estimate the project viability aspect (each weighted 10 or 15 points) included: developer experience; site status; steam user sign-on (where relevant); grass roots political support; stages of and success of engineering, licensing and permitting; acceptance by other utilities; proportion of project capacity already sold; and fuel contracting and logistics (*id.*). Factors used to measure or estimate the benefits and costs aspect included price, break even period (years until project price is less than avoided cost in that year), dispatchability; operating performance incentives, and three types of contractual risk: (1) pricing stability in case of fuel price increases; (2) a requirement to take power even when none is needed; and (3) economic soundness of the project (*id.*).⁴³ Factors accounted for under the goals and objectives aspect included: diversity of fuel (coal, nuclear, hydro and wood were preferable to oil) and technology (fluidized bed coal was preferable to combined cycle gas technology); timing relative to year of need for capacity; environmental and social concerns; location relative to transmission serving MMWEC members most effectively; ownership (MMWEC member ownership preferable to that by other utilities, which in turn was preferable to ownership by NIGs); and political support (primarily at the state level) (Exh. M-1, at VI -8; Tr. 3, at 139-146).⁴⁴ MMWEC stated that the assignment of points (or weights) to the various factors was a subjective determination originating with

⁴³ Of these eight factors, price (10 points) and pricing stability (10 points) counted the most, while economic soundness counted the least (*id.*).

⁴⁴ Of these factors, fuel diversity (25 points) counted the most (Exh. M-1, at VI -8).

MMWEC staff, then reviewed and adjusted by the energy committee, which is comprised of MMWEC members (Tr. 4, at 106-107).

MMWEC contended that it actually applied these screening criteria during 1989-1991 to the generation projects offering to sell electricity to MMWEC or its members, including three of the four NUG projects accorded planned status in MMWEC's filing (i.d. at 52). MMWEC had no specific pre-defined point scale for scoring any particular factor (Exh. DPU-136). Rather, MMWEC scored projects relative to other actual projects (Tr. 3, at 129). In order to determine project scores on each of the various factors, MMWEC staff developed initial rankings and then met to develop consensus scores for each (i.d. at 128-129). MMWEC reported its detailed screening results, factor by factor, for the projects which in 1989 or 1990 offered to sell electricity to MMWEC (Exh. M-1, at VI -21 through VI -24).

MMWEC admitted that its screening process was more important at the beginning of the 1990s, when new units were being proposed, than it has been more recently, because most current offers are by utilities selling electricity from existing units or from their systems as a whole (Tr. 3, at 146-147). For example, MMWEC's "viability" aspect does not differentiate among operating plants at all, since the probability of each becoming operational is already 100 percent (i.d. at 149).⁴⁵ Similarly, utility offers generally do not involve front loading or requirements to take power when it is not needed (i.d. at 149-150). Utility offers are usually for dispatchable power, and may carry less fuel price risk and better diversity

⁴⁵ Moreover, MMWEC admitted that viability becomes less important when there is capacity surplus in the region, as is currently the case (Tr. 4, at 114).

characteristics if they are based on a utility system as a whole rather than a particular unit (i.d. at 151-153). MMWEC added that since prices offered by utilities fall in a fairly narrow band and are subject to negotiation, terms and conditions assume added importance, making it very difficult to apply strict screening criteria (i.d. at 55-58).

MMWEC has developed and implemented a significantly more sophisticated set of screening criteria for supply-side resources since its last filing. The record shows that the screening criteria account for a wide variety of noncost factors that affect the desirability of contracting with a particular resource offered. The Department recognizes that MMWEC actually applied its screening criteria to projects proposed in 1989 and 1990. MMWEC did not formally apply its supply-side screening criteria to projects proposed after 1990. In addition, the Department recognizes that certain screening criteria employed by MMWEC do not distinguish among the types of projects available today. Nonetheless, MMWEC has captured many of the elements essential to an analysis of supply-side resources. MMWEC should be prepared to implement its full set of screening criteria should offers from non-utility projects materialize, and screening criteria could be developed to further examine important differences in the terms and conditions offered in conjunction with existing utility resources. Accordingly, based on the foregoing, the Department finds that MMWEC has established that it has developed and applied appropriate criteria for screening its set of supply-side resources.

(2) Demand-Side Management Resources

MMWEC developed its non-cost DSM screening criteria based on two primary inputs: ratings by member systems, and analysis of customer and load characteristics

(Exh. DPU-73). The member system input consisted of rankings on a scale of one to ten from "not applicable" to "very applicable" for 57 DSM technologies (RR-DPU-19). An analysis rated each technology on a four-point scale from "much below average" to "much above average" for each of six categories (Exh. DPU-73). The other six categories were (1) a summary of member input,⁴⁶ (2) proven performance, (3) cost-effectiveness, (4) customer acceptance, (5) load impact, and (6) the extent to which the technology would be implemented absent a DSM program (i.d.).

Based on the scores of the technologies in the six categories, 24 DSM technologies were selected for further analysis and 20 of them were actually analyzed (Exh. DPU-73; RR-DPU-22; Tr. 3, at 105). Using a wide array of assumptions (such as discount rate, customer incentive levels, savings per piece of equipment, and participation levels), MMWEC estimated energy and capacity savings for each of the 20 DSM technologies, also deriving per unit costs for energy and capacity by using estimated total program costs (Exhs. DPU-79, DPU-80). Ninety percent of the energy savings estimated by MMWEC's analysis came from six technologies (listed in order from the largest savings): commercial lighting; water heater wraps with low flow showerheads; industrial lighting; residential thermal storage; residential lighting; and variable speed drives (RR-DPU-22, at IV-8). Similarly, three-fourths of the estimated capacity savings came from five potential technologies or programs, listed in order of savings: interruptible rates for large customers; commercial lighting; water heater control; residential thermal storage; and pool pump control

⁴⁶ Members rated water heater wraps highest (Exh. DPU-73).

(i d., at IV-9, IV-10).

MMWEC identified prices per unit savings individually for each of its members, for each of many technologies (RR-DPU-22, at IV-12 through IV-42). The programs or technologies with the lowest median prices for savings were commercial lighting (1.8 ¢/KWH), water heater wraps (2.5 ¢/KWH), industrial lighting (3.5 ¢/KWH), residential lighting (4.3 ¢/KWH), residential thermal storage (5.5-6.0 ¢/KWH), water heater control (\$170/KW-YR), interruptible rates (\$230/KW-YR), and central air conditioning control (\$250/KW-YR) (i d.).⁴⁷ MMWEC analyzed its 20 DSM technologies according to four cost-effectiveness tests: the utility test; the participant test; the nonparticipant (no-losers) test; and the all-ratepayer test (RR-DPU-20). MMWEC then screened out DSM technologies which showed benefit-cost ratios less than 1.0 according to either the utility test or the participant test (i d.).

Combining the non-cost criteria and the cost criteria, MMWEC selected five specific cost-effective DSM programs to recommend to members, based on four criteria⁴⁸ (Exh. DPU-78). The five recommended DSM programs were (1) commercial lighting, (2) residential lighting, (3) water heater control, (4) interruptible rates, and (5) residential

⁴⁷ MMWEC's 1988 cost estimates for DSM technologies appear not to have incorporated feedback based on post-facto measurements of the type performed in Massachusetts since 1990 (Tr. 4, at 42). However, MMWEC failed to quantify or estimate the degree to which it may have overestimated the cost-effectiveness of the DSM technologies it examined (RR-DPU-27).

⁴⁸ The criteria were (1) program type already implemented by some MMWEC members, (2) program type being implemented by other utilities, (3) applicability to the largest number of MMWEC members, and (4) impacts that had been quantified or could be estimated with confidence (i d.).

thermal storage (Exh. DPU-73). MMWEC reported that almost all of its DSM savings come from efficient lighting in the residential, commercial, and industrial sectors, with some savings from direct load control of water heaters and previous improvements in street lighting efficiency (Exh. M-1, at VI -12).

The Department notes that MMWEC developed its DSM screening criteria based on consideration of internal factors such as load impacts and customer acceptance. The Department recognizes that MMWEC's screening criteria were generally well-founded in terms of their ability to assess the attributes of DSM options. MMWEC applied its screening matrix to a wide array of potential options in two steps to arrive at a set of five recommended DSM programs. However, the Department notes two weaknesses in MMWEC's use of its screening criteria. First, water heater wraps - the second most cost-effective DSM technology, which is also widely implemented by other electric utilities and top-rated by MMWEC members - were not recommended for implementation, while other DSM measures with costs twice as high were recommended. Second, by not using measured savings to adjust its benefit-cost ratios, MMWEC may have overestimated the cost-effectiveness of the DSM technologies which it examined (see Section III.E.2.a.(1), below). The Department encourages MMWEC to develop appropriate benefit-cost ratios for its DSM programs, such as those relying on measured savings, and to reevaluate water heater wraps as a viable DSM resource.

Accordingly, based on the foregoing, the Department finds that MMWEC has developed and applied appropriate criteria for screening its set of DSM resources.

(3) Conclusions on Development and Application of Screening Criteria

The Department has found that MMMEC has established that it developed and applied appropriate criteria for screening supply-side resources. In addition, the Department has found that, on balance, MMMEC has established that it developed and applied appropriate criteria for screening its set of DSM options. Accordingly, the Department finds that MMMEC has developed and applied appropriate criteria for screening its array of available resource options.

c. Conclusion on Identification of Resource Options

The Department has found that MMMEC has demonstrated that it compiled a reasonable array of available resource options. The Department has also found that MMMEC has developed and applied appropriate screening criteria for screening its array of available resource options.

Accordingly, the Department finds that MMMEC has established that it has identified a reasonable range of resource options.

2. Cost Effectiveness

As noted previously, the Department reviews MMMEC's supply planning process to determine whether MMMEC demonstrated that recommended resource options are (1) cost-effective compared to available alternatives, using methods such as competitive solicitations open to all bidders; and (2) not otherwise contrary to the public interest. The Department recognizes that this is a new standard of review being propounded and applied to MMMEC for the first time.

a. Cost Effectiveness Methodology

Mr. Boudreau stated that one of MMWEC's resource planning goals is to minimize the cost of the member systems' power supplies (Tr. 3, at 11). In addition, Mr. Boudreau stated that MMWEC's resource planning process is designed to treat all potential resource options on an equal basis (i.d. at 12; MMWEC Brief at 34). Mr. Boudreau indicated that the equal treatment of resources was effectively accomplished through the evaluation of all supply- and demand-side resources based on the same avoided costs (Tr. 4, at 3).

The Company indicated that MMWEC calculated avoided energy and capacity costs for member systems by (1) estimating annual bulk power costs for each member system, and (2) generating a second set of bulk power costs for each member system by adding a zero-cost proxy unit of 300 KW to 5,000 KW, depending upon the relative size of the member system (Exh. DPU-85). MMWEC stated that it then calculated avoided costs by dividing the difference between the two sets of bulk power costs by the total number of megawatt hours generated by the proxy unit each year (i.d.). MMWEC also stated that the Company used the production cost model, Proscreen II, to conduct generation expansion planning and system optimization analysis (Exh. DPU-93). MMWEC has not renewed various supply-side contracts, because it seeks lower prices and better terms (Tr. 4, at 69-70). Mr. Boudreau explained that contract renewals are expected to be made on terms superior to those of original contracts (i.d. at 69).

From time to time, MMWEC updated costs for supply-side projects as new proposals arrived, and updated avoided costs (see Section III.E.2.a, above). MMWEC stated that it did not recalculate the benefit-cost ratios for DSM programs after 1988 except when

requested by an individual member seeking to develop a program (i.d. at 21).⁴⁹

The record in this case indicates that MMIEC recommended delaying commitment to long-term supply contracts in light of plentiful, low-cost short-term transactions. The record also indicates that MMIEC relied on avoided costs as a key element in its cost-effectiveness activity. The Department recognizes that avoided costs are a useful component of cost analysis. However, the Department also recognizes that a weakness of MMIEC's cost-effectiveness methodology is its inability to provide a comprehensive and accurate view of competitive energy resource markets. Administration of a rigorous market test, through the issuance of requests for proposals, for example, would provide a more accurate view of actual market conditions, and would therefore be more likely to result in the procurement of resources at the lowest possible cost.⁵⁰ The Department further notes that cost considerations constitute a principal component of the resource evaluation process. Therefore, only the most reliable methods of cost evaluation are appropriate. In addition, the Department notes that use of late 1980's vintage avoided costs may seriously overstate economic analyses when compared to more current cost projections.

Based on the foregoing, the Department finds that MMIEC has demonstrated that its supply planning process is cost-effective. The Department encourages MMIEC to explore

⁴⁹ Regarding costs per unit of DM energy and capacity savings, Mr. Boudreau stated that MMIEC members have not undertaken load research or other investigations to measure the actual effects of their DM programs, nor was he personally familiar with the results of such measurements by investor-owned utilities in Massachusetts (Tr. 4, at 17-18).

⁵⁰ The Department notes that both supply- and demand-side resources may be procured through competitively structured bidding processes.

ways to enhance its cost-effectiveness practices, including competitive solicitations of demand and supply-side resources.

In addition to the foregoing cost-effectiveness activities, MMWEC noted that its supply planning process also addressed diversity, risk minimization, and environmental impacts (Exhs. DPU-99; DPU-97; DPU-89). Mr. Boudreau stated that MMWEC strives to maintain diversity in terms of fuel types, technologies, and ownership of facilities (Tr. 3, at 13). MMWEC added that its recommendations regarding resource acquisitions are made to limit reliance on any particular generating resource to less than ten percent of a system's total capacity requirement (Exh. DPU-99). See Section III.E.2, above, for a discussion of MMWEC's incorporation of a fuel diversity criterion in the screening process.

MMWEC stated that it has developed and implemented a probabilistic risk assessment methodology to evaluate its supply plan (Tr. 4 at 11-12). In addition, MMWEC stated that it has sought to minimize risk through negotiations for resource procurement with third parties (DPU-97). MMWEC indicated that it strives to obtain contractual provisions for security deposits, rights to terminate, milestone dates with deferral deposits, "take-and-pay" arrangements, capacity payments tied to availability, and corporate guarantees of performance by parent companies (i.d.). The Department notes that a new set of risks, as well as opportunities, have emerged in light of increased emphasis on competition within the electricity industry. Therefore, risk analysis and company planning must continue to evolve as well. MMWEC's risk analysis methodology would be strengthened by adding provisions that reflect the increasingly competitive nature of the electric industry.

In terms of environmental impacts, MMWEC stated that it will consider costs of

complying with the Clean Air Act Amendments in evaluating competing supply-side and demand-side resources (Exh. DPU-89). MMWEC claimed that a project which proposed offsets⁵¹ to its remaining emissions would improve its environmental score in MMWEC's screening system (Exh. DPU-137). Further, Mr. Boudreau called DSM resources generally much more favorable than supply-side resources from an environmental point of view (Tr. 4, at 25).

The Department notes that MMWEC's diversity, risk, and environmental impact components work in conjunction with and serve to enhance the cost-effectiveness aspects of MMWEC's supply planning process.

b. Public Interest

The Department notes that this is the first instance of a review of MMWEC's supply planning process using the new standard of review, which includes a demonstration by MMWEC that recommended resource options are not otherwise contrary to the public interest. Based on information presented in the record pertaining to MMWEC's supply planning process, for purposes of this review, the Department finds that MMWEC has demonstrated that recommended resource options are not otherwise contrary to the public interest.

c. Conclusions on Cost Effectiveness

The Department has found that (1) MMWEC has demonstrated that its supply

⁵¹ An offset is a reduction in an environmental effect elsewhere to compensate for an environmental impact caused by a generating plant. MMWEC did not indicate that any project proposal actually included offsets.

planning process is cost-effective; and (2) MMWEC has demonstrated that recommended resource options are not otherwise contrary to the public interest. Accordingly, based on the foregoing, the Department approves MMWEC's cost analysis.

F. Conclusions on the Supply Plan

The Department has found that MMWEC's supply plan ensures adequate resources to meet projected requirements throughout the forecast period. The Department has also approved MMWEC's cost analysis. Accordingly, the Department approves MMWEC's 1992 supply plan.

V. DECISION

The Department hereby APPROVES the 1991 Demand Forecast and Supply Plan of Massachusetts Municipal Wholesale Electric Company for the period of 1991-2001.

By Order of the Department,

Kenneth Gordon, Chairman

Mary Clark Webster, Commissioner

TABLES

TABLE 1. MMWEC's Base Case Demand Forecast and Supply Plan

Summer Peak (MW)				
Year	Capabi li ty Respon si bi li ty	Exi sti ng Capabi li ty	Base Case Surplus/Defi ci t	Percent
1993	758	920	162	21.3%
1994	799	900	101	12.6%
1995	820	839	19	2.3%
1996	839	848	9	1.1%
1997	857	849	-8	-.9%
1998	873	851	-22	-2.5%
1999	896	853	-43	-4.8%
2000	917	854	-62	-6.8%
2001	934	857	-77	-8.3%
2002	950	812	-138	-14.6%

Notes:

- a. Capabi li ty respon si bi li ty consi sts of peak load reduced by DSM opti ons and fi rm purchases, a reserve requi rement of 15 percent, and reducti ons due to P I P and normal i zati on.
- b. Exi sti ng capabi li ty i ncludes exi sti ng resources, plamed resources, plamed purchases, and proposed addi ti ons and purchases.

Source: Exh. M-5, at 1.